HYDROGEL-BASED TACTILE-FEEDBACK TOUCH SCREEN

I. CROSS REFERENCE

[0001] The present invention is related to co-pending application entitled "Tactile-Feedback Touch Screen" and having the inventors of the present invention in common.

II. FIELD OF THE INVENTION

[0002] The present invention relates generally to touch screen displays, and more specifically, the present invention relates to a system and method for providing tactile feedback on a touch screen.

III. BACKGROUND OF THE DISCLOSURE

[0003] Often times people unfamiliar with computers become intimidated with input devices such as mice and trackpads. Recent innovations such as the Apple iPhone have increased public awareness of, and desire for, touch-screen-controlled applications. Touch-screen interfaces provide the user with a more intuitive way of controlling a computer or electronic appliance.

[0004] Moreover, a touch-screen allows programmers to provide customized interfaces, which may be more appropriate for particular applications. Such as slider elements, buttons, dials and keyboards with keycaps tailored to particular languages and input requirements without requiring additional hardware. Reducing the hardware interface devices that must be provided allows manufacturers to reduce cost and increase portability of electronic devices

[0005] However, a significant disadvantage of touch-screen implemented interfaces is the lack of positive tactile feedback. For example, it is impossible to operate a "soft" keyboard while doing something else (such as flying an aircraft), because there is no way to feel where the keys are positioned. Similarly, it can be difficult for visually impaired people to operate such devices, as there is no means of providing Braille identification on the keycaps or other interface elements.

[0006] One attempt at solving the problem of identifying the position of an interface element, such as a button or dial, displayed on a touch screen display is disclosed in U.S. patent application Ser. No. 11/388,224 in which a flip cover is provided with one or more cutouts positioned to expose only the interface elements to a user's touch. In this way a user's finger is essentially guided to an interface element; and in the case of a dial or slider, the user's finger is guided along the path of the interface element.

[0007] However, the disclosed lid is limited to being utilized for only one particular arrangement of interface elements. Consequently, the touch screen display would not be capable of providing dynamic placement of interface elements based on the requirements of different applications being executed or functions being performed.

[0008] Moreover, rapid typing can be difficult on a touch-screen keyboard since the typist does not receive any feedback when a key is pressed on the screen. Thus, the typist must constantly review the typed information to ensure that the device has correctly registered key-presses.

[0009] Consequently, a need exists for providing tactile feedback to the user of a touch-screen device.

IV. SUMMARY OF THE DISCLOSURE

[0010] An embodiment of the present invention includes a touch-screen display having a digitizer layer for detecting a contact of a touch-screen display surface by a user; a gel layer for deforming discrete surface areas of the touch-screen display; a display layer for generating a display; and a tactile feedback controller for controlling the deformation by the gel layer. The gel layer has a honeycomb structure formed of a plurality of cells. Each cell of the honeycomb structure contains a quantity of hydrogel.

[0011] The gel layer further includes a first matrix of electrodes disposed on a top surface of the gel layer; and a second matrix of electrodes disposed on a bottom surface of the gel layer and oriented orthogonal to the first matrix of electrodes. Each pair of electrodes from the first matrix of electrodes and the second matrix of electrodes is vertically aligned with an individual cell of the plurality of cells.

[0012] Another embodiment of the present invention is a tactile feedback unit for providing tactile feedback on a touch-screen display. The tactile feedback unit includes a gel layer having a honeycomb structure having a plurality of cells. Each cell of the honeycomb structure contains a quantity of hydrogel. A first matrix of electrodes is disposed on a top surface of the gel layer, and a second matrix of electrodes is disposed on a bottom surface of the gel layer. The second matrix of electrodes is oriented orthogonal to the first matrix of electrodes. Each pair of electrodes from the first matrix of electrodes and the second matrix of electrodes is vertically aligned with an individual cell of the plurality of cells. Moreover, a tactile feedback controller is provided for controlling deformation of the gel layer.

V. BRIEF DESCRIPTION OF THE DRAWINGS

[0013] These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings wherein:

[0014] FIG. **1** illustrates a generalized cross-sectional representation of a conventional touch-screen display as known in the art;

[0015] FIG. **2** illustrates a cross-sectional representation of a touch-screen display having tactile feedback in accordance with an embodiment of the present invention;

[0016] FIG. **3** illustrates a cross-sectional representation of a touch-screen display having tactile feedback in accordance with another embodiment of the present invention;

[0017] FIG. **4** illustrates a planar view of the embodiment of the present invention shown in FIG. **3**;

[0018] FIG. **5** illustrates a flow diagram representing a series of steps for driving a scanning mode of an embodiment of the present invention as shown in FIG. **3**; and

[0019] FIG. **6** illustrates a representation of a typical application of an embodiment of the present invention.

VI. DETAILED DESCRIPTION OF DISCLOSURE

[0020] A conventional touch-screen display **100**, either LCD-based or LED-based, are constructed of several subassemblies, each of which have several component layers. The subassemblies are a backlight **102** (only used in LCD-based displays), display panel **104** and a digitizer panel **106** stacked